**CONSULTANTS GROUP**

GEOLOGY ENGINEERING ENVIRONMENT HYDROLOGY

May 14, 1993

Mr. Glenn Eurick
Barrick Mercur Gold Mine
P.O. Box 838
Tooele, Utah 84074-0838

RE: MAY 6, 1993 MEETING WITH DENNIS FREDERICK

Dear Glenn:

On May 6, 1993 you, me and Rick Pole met with Dennis Frederick, of the Division of Water Quality (DWQ) to review his HELP modeling work on the cap design for Dump Leach No.1. He had conducted a total of 13 runs of the model before the meeting (summary sheet attached). Basically these runs tested the sensitivity of changing three major cap parameters: the permeability of the clay layer, the curve number for the topsoil, the slope of the system, and the affect of a drain layer with a low-permeability subsoil above it. These are discussed below:

Affect of Reducing Clay Permeability

Using the assumptions shown on the summary sheet, (except all the percolation volumes in this memo are corrected for a heap area of 4.4 acres instead of 3.4 acres used in the model runs) the affect of reducing the permeability of the clay layer from $1.0 \times 10^{-5}$ to $1.0 \times 10^{-7}$ cm/sec was tested in model runs: Base, Case 2, and Case 3. The results of these runs are:

| Case | Clay K (cm/sec) | Perc. Rate (in/yr) | Perc. Vol. (gal/yr) | Percentage |
|---|---|---|---|---|
| Base | $1.0 \times 10^{-5}$ | 2.27 | 271,200 | 100 |
| Case 2 | $1.0 \times 10^{-6}$ | 2.25 | 268,800 | 99.1 |
| Case 3 | $1.0 \times 10^{-7}$ | 1.68 | 200,700 | 74.0 |

The reduction of permeability of the clay by 10 times, to $10^{-6}$ cm/sec, reduced the percolation through the clay by less than 1 percent. Reducing the permeability 100 times, to $10^{-7}$ cm/sec, reduced the percolation through the clay by about 26 percent. This indicates that, because of the low head conditions present on the clay layer, the permeability of the clay does not have as great a control on the percolation rate as would be expected. Achieving permeabilities for the clay layer on the order of $1 \times 10^{-7}$ cm/sec would be difficult in the field and such a compacted clay would be more susceptible to frost and root damage than a more permeable clay layer. Barrick has proposed to construct this clay to a permeability of $5 \times 10^{-7}$ cm/sec which should be readily attained during construction and should be a more durable clay layer than one with a lower permeability.

Affect of Increasing Curve Number

The runoff from the topsoil surface is calculated by the HELP model with the Soil Conservation Service (SCS) Curve Number (CN) technique. The HELP model runs from the base case through case 9 were all run with a curve number of 60. During numerous discussions and permit applications with the Utah Division of Oil, Gas & Mining (DOGM), Barrick has determined that the DOGM prefers to use the SCS CN technique for calculation of runoff from disturbed and undisturbed areas. The DOGM has approved a CN of 72 for undisturbed, vegetated surfaces at the Mercur site and a CN of 89 for disturbed sites. Thus it would appear that using a CN of 60 for the HELP model is not consistent with past practice at Mercur.

Using the same assumptions as the previous cases, the curve numbers were changed to test the sensitivity of the HELP model to the CN. These results are:

| Case | Curve Number | Perc. Rate (in/yr) | Perc. Volume (gal/yr) | Percent |
|---|---|---|---|---|
| Case 2 | 60 | 2.25 | 268,800 | 100 |
| Case 10 | 72 | 2.14 | 255,658 | 95.1 |
| Case 11 | 89 | 1.28 | 152,900 | 56.1 |

These runs indicate that changing the CN from 60 to 72 reduces the percolation through the clay layer by about 5 percent, a small affect. Increasing the CN to 89 reduces the percolation by about 44 percent. This affect is not linear and shows that CNs near 89 can result in a much larger amount of runoff than lesser CNs. However, a CN of 89 is too high for a vegetated soil surface and one about 72 should be appropriate for a fair vegetated cover on the surface of the cap.

Affect of Increasing Cap Slope

Increasing the slope of the cap increases the amount of runoff from the top of the cap and increases the amount of water the drains laterally in the permeable rock on top of the clay layer. Three runs of the HELP model were made to test the effect of changing the slope. These model runs are: case 10, 12 and 13.

| Case | Slope | Perc. Rate | Perc. Volume | Percent |
|---|---|---|---|---|
| Case 10 | 2 | 2.14 | 255,667 | 100 |
| Case 12 | 15 | 1.98 | 236,552 | 92.5 |
| Case 13 | 30 | 1.89 | 225,800 | 88.3 |

These results indicate that increasing the slope by over 7 times, from 2 percent to 15 percent, causes a 7.5 percent reduction in percolation through the clay layer. Doubling the slope again, from 15 to 30 percent only results in another 4.2 percent reduction in percolation. Thus the percolation rate is not very sensitive to the slope of the cap.

Affect of Adding a Drain Layer Between Two Low Permeability Layers

The model runs conducted by Dennis prior to our meeting were all done using a permeability of $5.0 \times 10^{-4}$ cm/sec. This would result in a greater impingement rate into the drain layer than if a permeability of $1 \times 10^{-5}$ cm/sec were used. This lower permeability is what Barrick thinks will apply to this material after it is placed. Dennis prepared a last run of the model using this permeability while we were at the meeting with the following results:

| Flow Component | Water Depth | Percent of Total |
|---|---|---|
| Precipitation: | 25.34" | 100 |
| Runoff: | 0.45 | 1.8 |
| Evapotranspiration: | 23.1 | 91.1 |
| Lateral Flow in Drain: | 0.45 | 1.8 |
| Percolation Through Clay: | 1.36 | 5.4 |

As can be seen, the annual percolation rate through the clay was reduced from the base case of 2.27 inches to 1.36 inches, a 40 percent reduction. The annual volume of water represented by this percolation rate is 162,500 gallons. However, the actual reduction in percolation volume through the cap, compared to Dennis' base case is on the order of about 100,000 gallons per year. Thus optimizing the cap design to reduce percolation by reducing the permeability of the subsoil from $5.0 \times 10^{-4}$ cm/sec to $1.0 \times 10^{-5}$ cm/sec, adding the drain layer, and reducing the permeability of the clay from $10^{-6}$ to $10^{-7}$ cm/sec would apparently reduce the annual percolation into the dump by only 100,000 gallons per year, about 0.84 inches or water per year.

It was mutually agreed to at the meeting, that the actual percolation rate through the cap would probably be on the order of about 200,000 gallons per year. It was thought that this amount of water (with chemical characteristics of the final rinsate) from the bottom of the dump is not likely to result in unacceptable impacts to ground water quality. It was agreed that an appropriate strategy would be for Barrick to conduct the pathway and fate analyses requested by the DWQ in their April 23, 1993 letter. If this showed that the ground water quality would be suitably protected, even if this amount of water leaked from the bottom of the reclaimed dump, there should be no reason to modify the cap design as originally proposed by Barrick. To avoid accumulation of this water in dump, the bottom liner could be purposely perforated.

If you have any comments or questions on this material please call.

Sincerely,

Brian

Brian W. Buck
Vice President

cc: R. Pole, JBR